Helios Mission Support

P. S. Goodwin
TDA Mission Support

G. M. Rockwell
Deep Space Network Operations

This article reports on activities of the Network Operations organization in support of the Helios Project from 15 June through 15 August 1977.

I. Introduction

This article is the seventeenth in a continuing series of reports that discuss Deep Space Network support of Helios Mission Operations. Included in this article is information on Helios-2 superior conjunction period, a further report on Faraday Rotation experimentation (Ref. 1), the DSN Mark III Data Subsystems (MDS) update at Deep Space Station 14 (Goldstone, California), and other mission-oriented activities.

II. Mission Operations and Status

A spacecraft emergency was declared for Helios-1 on July 12, 1977, when DSS 42 (Australia) lost the downlink, and subsequent contingency sweeps to reacquire the downlink were unsuccessful. The spacecraft was then commanded, through the Australian 64-meter station, DSS 43, to go to 8 bits per second. Following this data rate change, lock of the downlink signal was achieved. The first analysis of this data showed that the transmitter in the spacecraft had gone to the medium-gain antenna from the high gain, the power regulator had gone from 1 to 2, and all experiments had turned off. The regulator switch, for reasons unknown, had caused a power drop causing the spacecraft's high-gain antenna to move off point. This resulted in the loss of the downlink. The spacecraft was then commanded back to the high-gain antenna, and the normal configuration restored. All experiments were turned on with the exception of Experiment 10, which would be restored when sufficient power was available. On July 21, 1977, Experiment 10 was restored.

On July 18, 1977, the Helios-2 spacecraft passed through its fifth aphelion at 0025 GMT. The spacecraft was at a round-trip light time of 31 minutes, 31.7 seconds. Ground station coverage was over DSS 44 (Australia) at a bit rate of 32 bits per second coded, having a signal-to-noise ratio of 5.7 dB and a downlink AGC of -157.6 dB.

As reported in the last article (Ref. 1), Helios-2 entered a blackout period on June 2, 1977. The exit from blackout occurred on June 28, 1977, pass 531 over DSS 63 (Spain). On this first day, the downlink signal would not hold solid receiver lock and no telemetry was processed until the next day. On June 29, the first data (8 bits per second) were processed over DSS 63 with the spacecraft at a Sun-Earth-Probe (SEP) angle of 0.868 degrees. The first uplink was performed on July 2, 1977, over DSS 63. Also, the Faraday Rotation Experiment and the Solar Wind Experiment (Ref. 1) were resumed following Helios-2 exit from blackout. The progress of these experiments will be discussed later in this article.

Overall tracking time for both Helios spacecraft for this period is shown in Table 1.

III. Special Activities

A. DSN Mark III Data Subsystems (MDS) Support of Helios

Since the last article, which reported that DSS 14 was undergoing MDS implementation, DSS 14 has entered the MDS testing and training phase (as of June 24, 1977). The planned combined data flow test (Ref. 1) was canceled and each project proceeded with its own training program. The first Helios demonstration pass was conducted on June 25, 1977. Since that time, a total of 24 demonstration passes have been conducted over DSS 14. Overall, these tests have been a success with the majority of problems being operational rather than equipment related. These operational difficulties have at present been minimized through continued training. As a result, the station personnel have become highly knowledgeable of the MDS system and its operation. As of August 1, 1977, DSS 14 has been placed under configuration control for Helios operational support, and the test and training period for Helios was concluded. The standard Helios configuration for DSS 14 is shown in Figure 1.

On July 15, the Australian conjoint complex (DSS 42/43) was taken down for MDS implementation. They are scheduled to begin their MDS test and training phase on September 30, 1977. The progress of DSS 42/43 will be covered in the next article of this series.

B. Radio Science Activity

As mentioned in the last article, the scientific interest in this phase of the Helios-2 mission is very high (May through October 1977). The two experiments being conducted are Faraday Rotation and Solar Wind. These were discussed in detail in the last article. This article will give the status of each. Also, some preliminary results of the data collection accomplished to date will be presented.

The Faraday Rotation Experiment was performed by making solar occultation measurements. These measurements were made in two phases, entry and exit. The entry phase occurred from May 15, 1977 through June 2, 1977. Tracking coverage for the entry phase was provided by DSS 43 and DSS 63. Two types of data, polarization angle and ellipticity, were collected during these passes. Of the 17 passes over DSS 43, 10 resulted in good polarization data, but none for ellipticity. Over DSS 63, from a total of 12 passes, 8 provided good polarization data while 5 provided good ellipticity data. Overall coverage of this entry phase went well, and the data are in the final stages of processing at this time.

The exit phase of the experiment occurred from June 26, 1977 through the present. Through this phase, coverage has been provided with 18 passes from DSS 14, 17 passes from DSS 43, and 19 passes from DSS 63. No processing of data has occurred so far, but preliminary observations of the data packages show some poor stripchart labeling and tape handling from DSS 14, which may hinder analysis. The other stations' packages appear in order and should not present any difficulties. Procedures will be refined so that the above problems will not occur in the future.

The other major experiment reported earlier (Ref. 1) was the Solar Wind Experiment (SWE). This experiment has been progressing rather smoothly. The experimenters have had many tracks and the coverage has been excellent, especially near the Sun. Over 100 hours of simultaneous two-station, long baseline observations of Helios-1 and Helios-2 high-rate doppler residuals have been collected. The experimenters have found that the one-way data contain the effects of instability of the on-board oscillator as well as the solar wind. They have come up with a scheme to mathematically remove the effects of this oscillator instability while providing a measurement of solar wind velocity at the same time. The experimenters have also begun a series of spectral broadening and one- and two-station intensity scintillation observations at DSS 13 and 14. They have demonstrated that the solar wind velocity can be measured using DSS 13 and 14 intensity scintillations, and plan on doing so for the heliocentric distance range of 5.5 - 25 R_0. These measurements will complement the SWE and allow comparison of solar wind velocities determined by two different methods. To date, the experimenters have collected DSS 13 and 14 data on 11 days and a more extensive set of single-station spectral broadening data.

Both of the above experiments will be reported on in the next article, when further results will become available.

Reference

1. Goodwin, P. S., Burke, E. S., and Rockwell, G. M., "Helios Mission Support" in the Deep Space Network Progress Report 42-40, Jet Propulsion Laboratory, Pasadena, California, June 15, 1977.

Table 1. Helios Tracking Coverage

Month	Spacecraft	Station Type	Number of Tracks	Tracking time (Hours, min)
June	Helios 1	26 m	57	393:56
		64 m	2	8:22
	Helios 2	26 m	1	5:55
		64 m	16	29:43
July	Helios 1	26 m	47	302:24
		64 m	2	8:18
	Helios 2	26 m	5	4:44
		64 m	58	221:22

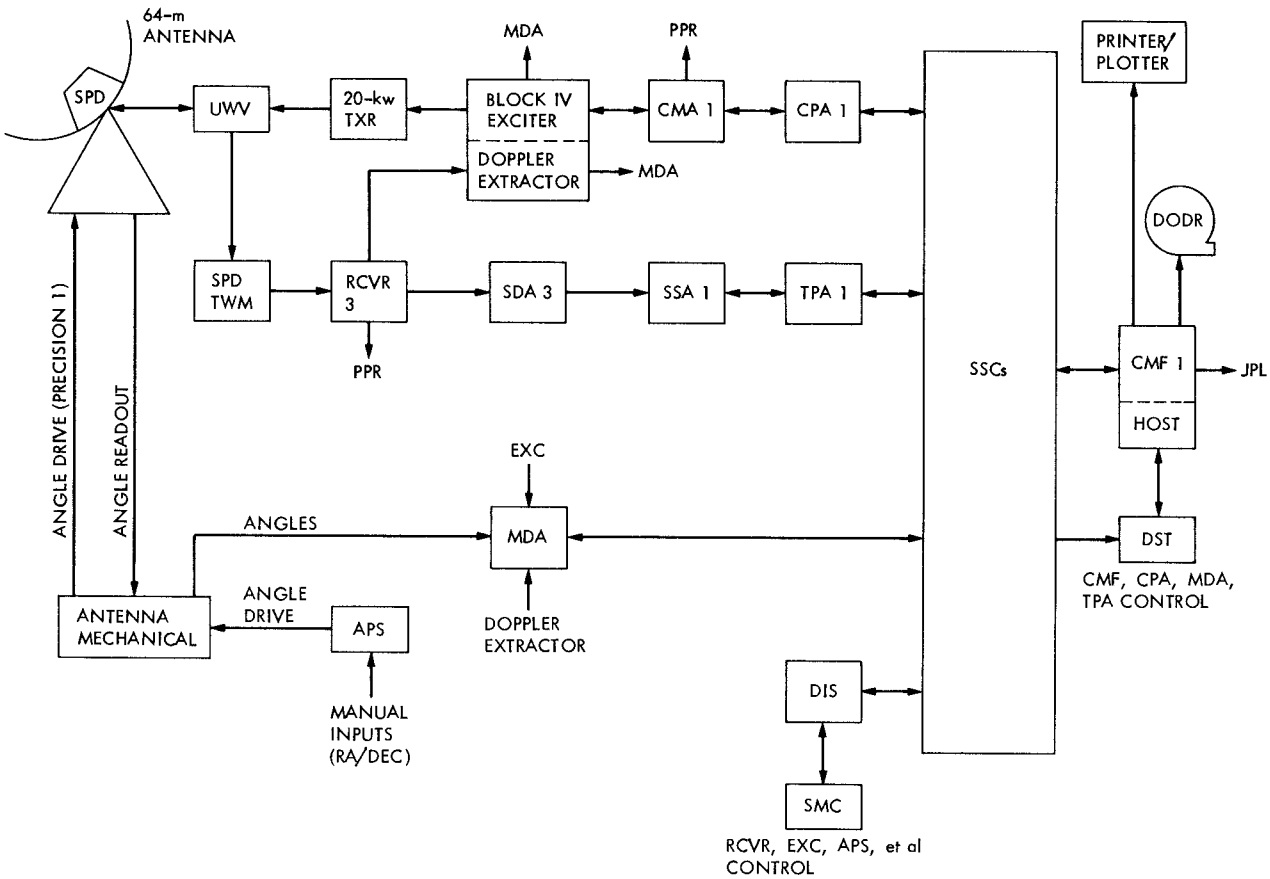

Fig. 1. Standard Helios configuration for DSS 14